Smart Government infrastructure based in SDN Networks: the case of Guadalajara Metropolitan Area

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Abstract— Guadalajara city is in transformation towards being a Smart City, for that it has to improve its IT infrastructure. As part of the Smart City development process in Guadalajara Metropolitan Area, Jalisco State Government is improving its IT infrastructure towards a Smart Government developing more services connected to the citizens. With 8.14 million inhabitants in Jalisco State, the 61% has concentrated in de metropolitan zone; every online service must support connectivity of millions of users in peak periods with a good quality of service and user experience. As an example, each year the government has to collect taxes for the city, creating peaks of connectivity into tax offices. With the integration of Cloud Computing services, we present a study of accessibility for the citizens through to mobile platforms looking to orchestrate data flows with Private Cloud Infrastructure and Software Defined Networks (SDN). Based on open source solutions, this paper presents a collaborative experience among Government and Academia in the implementation of a private Cloud together with SDN technologies offering advantages in Cloud services to improve Smart Government services. Also through of implementation of IoT devices, the tax offices sense and monitor different environment variables to improve services.

Keywords—Smart Cities, infrastructure, Smart Government, SDN Networks, Cloud Environment for Government.

I. INTRODUCTION

When a city decides to become Smart City, one of the first actions is to improve the IT infrastructure as well as run a review of public policies to upgrade the government services to what is known as Smart Government. This upgrade in government services increases the engagement the citizens creating a participation environment forcing to implement more innovative forms of governance in cities [1]. Some authors mention that Smart Government includes open government as the game changer to establish an open dialogue between all Smart City stakeholders (citizens, academia, industry, government members) and proposes new methods of interaction [2].

Jalisco State in Mexico holds 8.14 million inhabitants where 61% (5 million) stay in what we call Guadalajara Metropolitan Area (GMA) with eight integrated municipalities becoming the second major urban area in Mexico after Mexico City [3][4]. Hence, any improvement in GMA towards Smart Cities becomes an essential reference of experience for other cities in Mexico.

For Jalisco State, a first step was to use IT to enhance quality and performance of urban services reducing costs and resource consumptions engaging more actively and effectively with the citizens as described by Hollands [5]. By implementing Cloud Computing services, it is possible to achieve integration of storage, processing, and resources in the traditional data centers. It makes easier to assign, manage and monitor them [6].

Consequently, a common practice for the Smart Government is to start offering city services in IT platforms supported by private cloud infrastructure [7]. A natural step is related to the ubiquity of city services connecting to mobile platforms bringing more accessibility to citizens as well as adopting standards to include third-party services as related in the PRISMA project [8].

As the Open Government connects better with the Citizens, Open Data repositories grow in volume and frequency fed by sensors as a result of IoT devices and human interactions in the digital systems. Most of the data creates geospatial data sets of all activities in the city helping government authorities and citizens to have more insights to support decisions for a better quality of life day by day and creating a Big Data challenge [9]. Therefore, cloud services must include Networks Virtualization technologies known to start with the Software Defined Networks (SDN) to improve efficiency in the daily Big Data decision process at the Smart City [10][11].

The work presented in this paper aims to release and to share the lessons learned in Jalisco State as well as improvements in Smart Government Services in the GMA realized in cooperation with the University of Guadalajara, moreover identified, best practices for the Cloud and SDN technologies implementation for a Smart Government strategy.

II. PROBLEM STATEMENT

Smart Cities require being able to use resources effectively and efficiently, besides the resources must have elastic and flexible digital platforms. The services that Smart Government must deliver to citizens must have the ability to integrate, coordinate and automate multi-system architectures [7].

The principal challenges when it is implemented a multi-system architecture in Cloud Computing are [7]:

1) *Security and Privacy*
2) *Delivery and Service Billing*
3) *Portability and Interoperability*
4) *Reliability and Availability*
5) *Performance and Broadband Cost*

For that reasons, the government has to operate over an interconnected world that is volatile, uncertain, complex and ambiguous. The technology innovation assertive and well-educated stakeholders with the data analysis can grow the opportunities for good government public services. Public sector leaders must be work in the design and delivery of services meant to demonstrate the value that the government can give to the society [12].

Tax payments are one of the activities carried out by the government each year. Traditionally people go to tax offices
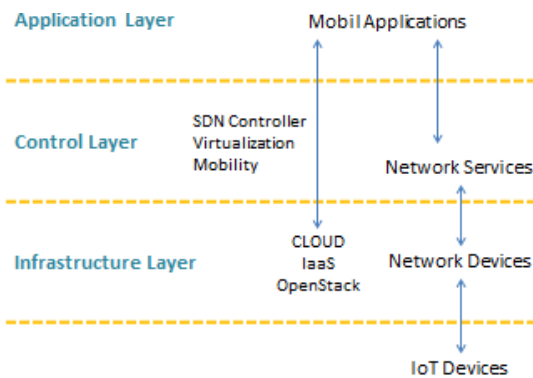

Fig. 1. Architecture SDN for incorporation of Cloud Service using OpenStack

for payment transactions, which involves the citizen mobility and the investment of time in long queues. Keeping such services in physical public offices has as consequences a significant concentration of people in the tax collection offices and high energy consumption in the area. If the government wants to optimize this service with a digital solution for the citizens, the service needs to offer portability, availability, and reliability, guaranteeing privacy and security

in the realization of this payment.

These problems can solve through an SDN architecture incorporating of Cloud services to improve the access of users to the mobile applications available for the payment of taxes Fig.1, The IoT devices are incorporated directly to the infrastructure using the Network devices, the control layer is in charge to guarantee that the mobile applications had access to the cloud infrastructure in which the services reside.

III. ONLINE SERVICES INFRASTRUCTURE MODEL IN JALISCO STATE AND GUADALAJARA SMART CITY

One of the elements that have had an exponential growth in the last years has been the reference to the financial operations of the Government as part of the flexible integration of new online services, among which online payments stand out and interact with different platforms. The most important of interconnection of platforms are that by their nature are link are among other levels of government, private organizations and the national and international banking sector. The low-cost of mobile technology among citizens makes it more feasible to offer new applications that address society's need to make contribution services more affordable using electronic platforms under a flexible and elastic infrastructure in a Smart City that tends to automate its processes collections towards to use emerging models, like the computational Cloud. Only in the period between January 2016 to May 2018 according to monitoring figures in the Google Analytics platform among users of the online payment portal https://gobiernoenlinea1.jalisco.gob.mx, from 3,578,187 to 8,443,281 users. increased the traffic from 1,536,843 to 3,169,813 mobile devices and tablets [13] see Fig. 2. The Fig. 2, shows the increment of users related to the same period from the last year. The traffic of mobile devices had an increment of more than 100%.

Working together Government and Academia, supported a model of architecture at the application level based on industry standards, where the base platform is on GNU Linux and natively in Java programming language, giving portability and speed to desktop users and accessibility to mobile devices iOS and Android. See Fig. 3.

Under the traditional model of online services that increases year after year, new flexible and elastic capacities detonated that by their nature reduced to new investment in infrastructure, which increases the annual budget in this segment. To face this problem, a new platform developed for the government need to align with the new technological architectures of the industry and expansion of the computational Cloud and emerging services. Services such as the internet of things, need to be integrated into solutions that are fast to integrate and even lower investment cost and
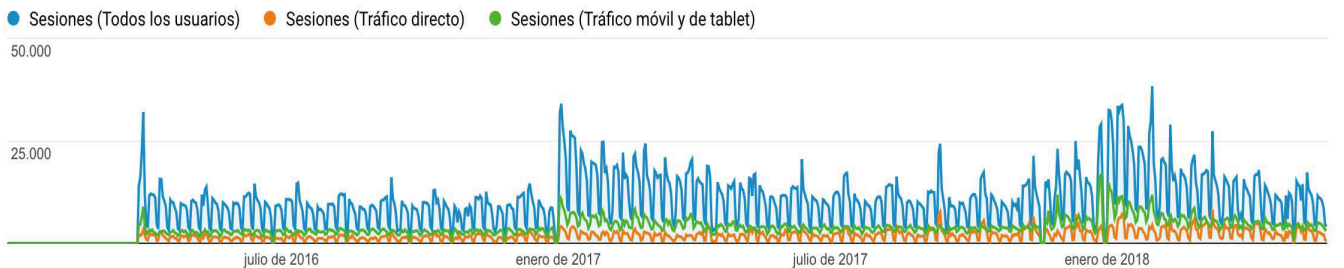

Fig. 1. Graph of increase in users and traffic of mobile devices and tablets.

in a shorter period than the traditional model of online services and that also allow interoperability of architectures.

Public policies through Jalisco open data [14] in the field of information technologies focus on bringing services and information to citizens, allowing them to interact and be participants in the change and get involved in the solutions of the metropolitan area. Guadalajara through the open data integrates better decision-making in a city that is expanding at an accelerated pace allowing, in short, open platforms that involve the citizen in the process of transparency.

Whit the integration of these solutions, all the development of the digital platform fits into a computational Cloud within government services of Jalisco. On the digital solution, we kept in mind the interoperability with the deployment of open source technology based on OpenStack and focused on Open Infrastructure with hybrid Clouds architecture [15]. In this way, we can reuse technology and computing capacity with a zero investment in infrastructure, since the flexibility of architectures based on open standards allows integrating a portfolio of solutions with more reach and elasticity under an interoperable environment.

Standardization of its processes has gradually led to an integration in adherence to ISO-20000-1 [16] to the management of services of information technologies, which allows the processes to be aligned and link emerging services such as SDN (Software Defined Network). Using SDN technologies correctly, we can envision to integrate new services such as the Internet of Things. We present a specific case allowing to improve the quality and perception that citizens use in traditional e-government services.

Integration of banking processes and interoperability with other financial institutions allows flexible solutions to integrate web services and micro-services with SOA (Service-Oriented Architecture) making the services more efficient in the Government of Jalisco bringing citizen secure and accessible digital platforms. With these government services we directly address different problems that the Guadalajara Smart City develop as a digital service to avoid the concentration of citizens in physical offices with service windows, resulting in more efficient the energy consumption, reducing mobility and pollution, as well as increasing overall productivity in the city. In this way, the city becomes efficient. Besides, as a strategy, we look to integrate the digital services of the government more integrated into computational Cloud solutions for better management.

IV. CLOUD AND SDN AS A SOLUTION TO IMPROVE E-GOVERNMENT SERVICES

OpenStack is a convergence platform for IT services lodgment, through a control panel for the management. Through a web interface, that offer auto-service functions which allow users provision resources instantly [17].

OpenStack together with SDN (Software Defined Networks) provides several advantages over Cloud Computing Services to Smart Cities. Chang proposes [18] a method implement SDN technology to monitor and analyze a periodic broadband use with the goal to find and mitigate the network congestion.

This monitoring allows stabilizing the services that operate within the computational Cloud based on OpenStack. For the Jalisco State Government, this monitoring service represented a significant saving in the first release of services to take control through integrated sensors with a raspberry pi platform in one of its offices, inside of the first results highlight the non-saturation of people going to these offices for the increasing use of digital financial platforms.

The sensing parameters that were carried out were to measure the flow of people within the tax collection office.
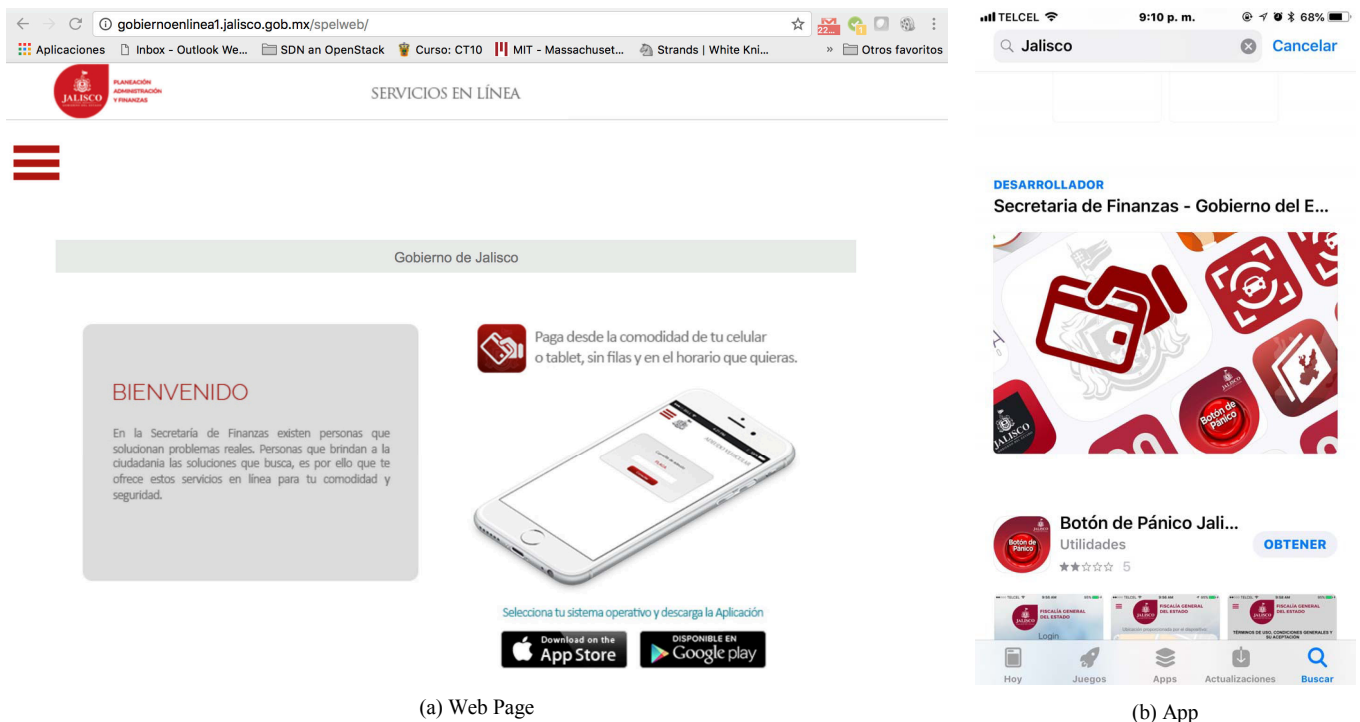

(a) Web Page

(b) App

Fig. 3. Online services Government of the State of Jalisco

We analyzed parameters of operations at the public tax window through movement in each IoT box, and it allowed estimating an adequate flow of operations and a decrease in the use of energy to have the heated area in a more orderly manner compared to the first quarter 2018 with 2017 Fig. 4.
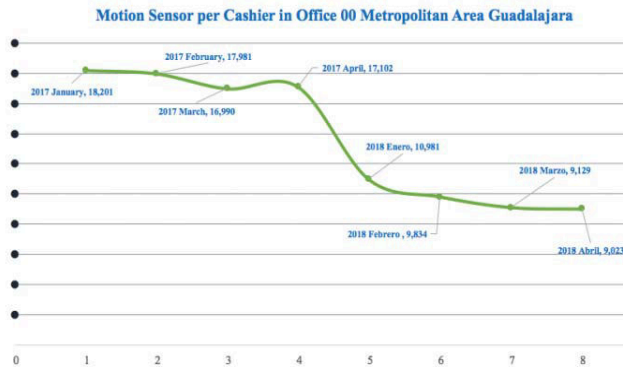

Fig. 4. Motion Sensor per Cashier in Office 00 Guadalajara Metropolitan Area

V. CONCLUDING REMARKS AND PERSPECTIVES

Based on the peak event of tax payment for the Jalisco State Government, was an excellent example to improve IT infrastructure to orchestrate data flows in the private Cloud of the government IT platforms. Most of the implemented solutions were a collaborative effort testing scenario at the academia and implementing best results in government services as part of the Smart City project. If SDN implementation is starting as a promising technology, this case of study opens the door for more complex scenarios to test and support. With the integration of IoT devices in Government offices, more data may be gathered to decide how to improve services for the citizens and increase their participation. As a final result, we foresee to continue growing the experience and collaboration among academia y State Government.

ACKNOWLEDGMENT

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